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Agriculture Development Fund

FINAL REPORT

20000057

FEEDING AND MANAGEMENT TO MAXIMIZE DESIRABLE FATTY ACID CONTENT IN MILK AND BEEF

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Prepared by: University of Saskatchewan

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Project 20000057

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Feeding and Management to Maximize Desirable Fatty Acid Content in Milk and Beef

Final Report

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Final Report

A. Abstract

This project was carried out to determine the effect of lipid sources on milk yield and composition with specific emphasis on the effects on desirable fatty acid content of milk fat. Conjugated linoleic acid (CLA) is produced by rumen micro-organisms and transferred to milk fat. Alpha linolenic acid (ALA) constitutes half of the fatty acids in flax oil and can be directly absorbed and transferred to milk fat or partially converted to CLA. In a dairy production trial in which raw and micronized flax seed were fed it was found that both ALA and CLA content milk fat were increased. In a second trial in which whole sunflower seed was fed there was a substantial increase in the CLA content of the milk fat. These fatty acids are known to have beneficial effect on human heart and circulatory system and also suppress tumor development and growth. This research will be continued with both beef and dairy cattle in a new ADF operating grant.

B. Executive Summary

The objective of this project was to determine the fatty acid composition of milk and meat as affected by fatty acid source and rumen conditions. Milk and meat have been associated with both lower gut tumor formation and development of heart and circulatory disease. These undesirable effects are associated mainly with saturated fatty acids containing either 14 or 16 carbons. The medical evidence of the undesirable effects of milk are uncertain while the effects of beef fat are more generally accepted. There is recent evidence that fatty acids either produced in the rumen or transferred from feed through the rumen to meat and milk may have beneficial effects on human health that outweigh the undesirable effects that are more widely known. Conjugated linoleic acid (CLA) is produced by rumen bacteria and is transferred to milk. Under conditions of high grain feeding with low levels of fat in the ration there is a very low level of CLA in the milk. When dairy cattle are fed high levels of forage, especially pasture grass which contains substantial amounts of unsaturated fatty acids, the milk will contain two to three times the amount found when high concentrate and hay rations are fed. It has also been found that supplementing the ration with certain forms of lipid may increase the CLA content of milk. In our research we used flax seed in a dairy production trial and found this feeding of flax doubled the CLA content of milk fat and depressed both the C14 and C16 fatty acids. Flax oil contains a high level of alpha linolenic acid (ALA) which is partially converted to CLA in the rumen with the ALA content of the milk also increased. ALA like CLA has both anti tumor properties and also maintains heart and circulatory system health. In a second trial whole sunflower seed which contains 40% oil (of which 65% is linoleic acid) were fed to lactating dairy cows. In this trial it was also found that the CLA content of the milk fat was doubled. Under some feeding conditions it was found that milk yield was substantially increased by feeding one kg of whole sunflower seed daily with little or no depression in milk fat or protein percentage.

These trials indicate that feeding of oil seeds such as flax and sunflower can dramatically alter the fatty acid composition of the milk fat. One implication is that diary processors in western Canada have the opportunity to produce specialized milk with altered fatty acid composition. Such milk is produced in some Asian countries at present. Another opportunity is to market Canadian oil seeds or oil seed products both within North America and in the Asian market for use in dairy rations. A new ADF sponsored project arising from this work will continue studies with dairy but will emphasize work with growing-finishing beef cattle. A related ADF project will examine the effect of feeding system on the fatty acid content of bison meat.

C. Technical Report

The objective of this project was to determine fatty acid composition of milk and meat as affected by fatty acid source and rumen conditions. The original application was approved for one year with the expectation that the project would continue for two to three years. Substantial progress has been made in this one year project and additional funding has been obtained under Project 20010045 Res 29AD. This is a three year

project with total-funding of $123,000. Some aspects of the current project (20000057) remain to be completed and will be reported as part of the new project. The intent of this project is still to determine factors that influence CLA and DHA content of milk and beef fat. In addition the bison project funded under the supervision of Murray Woodbury (WCVM) will provide additional information on the effect of forage and concentrate finishing rations for bison. Some aspects of this work are also related to the Strategic Ruminant Nutrition ADF Sub-program R-01RP. The ultimate benefit of this work is the opportunity to improve intake of these fatty acids in the human diet and to develop milk and meat products that have widespread consumer acceptance. There is ample medical evidence indicating that these fatty acids are beneficial to human health.

In Progress Report #1 a dairy feeding trial based on raw and micronized flax seed was conducted with lactating dairy cows. Flax oil is characterized by having a high content of alpha linolenic acid. This fatty acid is related to a reduction in tumor formation and growth, to an improvement in heart and circulatory health, and to the improvement in skin conditions and possibly to improved immune status. The feeding trial reported previously did not alter milk yield or milk fat percentage. However, the conjugated linoleic acid content was doubled in the milk fat and also the linolenic acids (C18:3) was increased. There is no processing plant in Saskatchewan that can take advantage of increased ALA and CLA content of milk. However, a processing plant in Quebec has shown interest in producing such a milk and samples of micronized and raw flax were shipped to a faculty member at Macdonald College (Arif Mustafa) for studies to be used with his research dairy herd. There is also an interest in Taiwan and Korea for products containing flax. A Saskatchewan company, Werner Agra Ltd., has developed a product containing extruded linseed with a 10% lipid content that is now being exported to those countries. If the opportunity arises similar studies with this flax product in beef cattle rations will be conducted. A related trial is now underway in cooperation with Andrew Van Kessel on the effect of feeding Lin Pro, the product produced by Werner Agra Ltd., to cows just before and just after calving. The purpose of this work is to determine the effect of Lin Pro on the immune system. This project is funded mainly by NSERC and Dairy Farmers of Canada. Werner Agra Ltd. is supplying the material and some evaluation of the quality and nutritional characteristics of the product are being monitored. The protocol for this project is contained in Appendix A.

Following distribution of information on our flax seed dairy trial interest was generated by several sunflower seed growers and by distributors and the head office of Pioneer Seeds. They requested that work on sunflower seeds be conducted using similar methodology to that for the flax trial. Sunflower seed was provided by Jim Tanner, a sunflower grower and seed distributor near Regina. Roasting of sunflowers was arranged by Werner Agra Ltd. located in Regina. The protocol for the initial production trial is shown in Appendix B. This trial will become part of Amanda Kroeker's M.Sc. project. She will continue this work as part of the new ADF project. Interest had been shown by sunflower seed growers more than 10 years ago and an ADF demonstration project (#D-90-HE-0885) was conducted in 1991 at the Hinrichsen dairy farm. In this trial milk yield was increased, however, milk fat percentage was decreased. Under the milk pricing system at that time this was not a favorable situation. However, at present a feeding program that will reduce milk fat percentage while maintaining or increasing milk protein percentage is economically advantageous to a dairy farm. This is due to the nature of the multiple component pricing system now in effect in Saskatchewan.

In the recently completed trial using the University of Saskatchewan dairy herd (Appendix B) there was no increase in milk yield (Appendix C). Milk yield averaged 38 to 39 kg per day through the four month trial. Surprisingly milk fat percentage was maintained and protein percentage only slightly reduced. Preliminary results indicate that there was a substantial increase in CLA content of milk fat, however, these analyses are not yet complete. In a subsequent switchback trial using the whole University of Saskatchewan herd one kg of roasted sunflower seeds were fed for a 30 day period and then raw sunflower seed was fed for a subsequent 30 day period. Appendix D contains a summary of this information. Milk yield was

substantially increased by both roasted and raw sunflower seed with 3.5% fat corrected milk being increased more than two kg daily compared to the pre and post sunflower seed feeding months. Both fat yield and protein yield were increased by both raw and roasted sunflower seed. One of the ration alterations that was made was an increase in the calcium and magnesium content of the rations which has been found in other research to assist in maintaining milk protein and milk fat content when high levels of unsaturated fat are fed. Appendix E contains an economic analysis of the effect of feeding sunflower seed on milk revenue. The increase in milk revenue was more than $2.00 per cow daily. It was also found in a palatability and preference trial that raw and roasted sunflower seeds were equally acceptable and were readily eaten by dairy cows when fed either separately or mixed with a total mixed ration.

These results have stimulated considerable interest by sunflower growers and seed distributors. It should be noted, however, that there is no sunflower breeding and selection program conducted in Canada at present. Agriculture and Agri-Food Canada evaluate varieties and make recommendations on varieties. The only type of sunflower seed evaluated in these trials is the high oil type containing approximately 42% in the dry matter. Due to the interest in these trials, David Christensen was asked to make a presentation summarizing them at the National Sunflower Association of Canada annual meeting in Portage La Prairie on December 6th, 2001. The PowerPoint presentation and summary is included in Appendix F.

In future work which will be funded by the new ADF project and partially by ADF Strategic funds emphasis will continue on evaluation of sunflower seed and the effects of roasting and crushing on rate and extent of fibre fermentation in the rumen. Amanda Kroeker will complete these studies as part of her M.Sc. program and Henry Soita, who is supported by the ADF strategic program, will provide assistance.

D. Personnel

Name

Amanda Kroeker (Graduate Student)
Neil Webb

D. a. Lab Supplies

E. Equipment

No equipment was purchased for $1000 or more.

F. Project Developed Materials

See material in Appendix.

G. Project Photos

None.

H. Acknowledgement

Acknowledgement of Saskatchewan Agriculture Development Fund support was acknowledged in the presentation to the National Sunflower Association of Canada.

I. Expense Statement

The statement of expenditures will be provided by the University of Saskatchewan.

APPENDIX A

Effect of Feeding Lin Pro to Dairy Cows Pre/Post Calving

October, 2001

1. Objectives: To measure the effect of Lin Pro on the immune response of dairy cows under stress (calving). To measure the effect of Lin Pro on the fatty acid profile of colostrum and milk.
2. Treatments:
   a). Control: Standard University of Saskatchewan feeding program
   b). Lin Pro: One kilogram of Lin Pro will replace one kg of dairy concentrate.
   c). Soybeans: One kilogram of roasted soybeans will replace one kg of dairy concentrate.

3. Standard U of S feeding program: Dry cows and heifers are moved to individual boxstalls 14 days prior to due dates. Cows are fed 12 kg of the high production group TMR which contains 35% concentrate on an as fed basis (equivalent to 4.2 kg concentrate). Cows also receive one kg/day of a barley based Vitamin E/ Niacin supplement. Total daily concentrate intake is 5.2 kg or about 0.8% of bodyweight. The remainder of the TMR consists of barley silage, chopped alfalfa hay and dehy pellets. Cows are fed one kg of long alfalfa hay per day plus good quality grass hay to appetite. TMR, vitamin E supplement and grass hay are fed at a 9 am feeding with alfalfa hay fed at a 4 pm feeding. Additional grass hay may be fed in the evening or at the 4 am milking. After calving the TMR is raised by 2 kg and 3 kg on alternate days. Grass hay is decreased while alfalfa hay may be increased dependant on appetite. Total hay is decreased over 5 to 10 days post calving while TMR is increased. Cows with normal appetite are moved to the high production group as soon as there is more than 1 kg TMR weighback. This amount may vary from about 21 kg for heifers up to about 34 kg for cows. Cows with problems (retained placenta, milk fever, abomasal displacement) may remain in the boxstalls until appetite is normal. After moving to the high group cows continue to receive one-half kg of vitamin E supplement per day fed in the parlour at the am milking to 28 days post calving.

4. Lin Pro will be provided by Werner Agra Limited, Regina, Saskatchewan.
   Roasted Soybeans purchased from New Life Feeds, Saskatoon, Sask. Received October 5.
5. Feeding Management Changes: The TMR will be adjusted to contain one kg less dairy concentrate. Cows will receive one kg dairy concentrate, one kg Lin Pro or one kg roasted soybeans which will be hand mixed into the TMR. The products will be fed at a level of 0.5 kg for the first 3 days for adjustment. Cows should remain in boxstalls for a minimum of 10 days after calving.

6. Available Cows:

Eartag	Lactation	Sire	Due Date	Treatment	Comments
382	2	Megaton	Oct 14	C	VIDO vacc
378	2	Rudolph	Oct 15	R	VIDO vacc
386	2	Megaton	Oct 17	L	VIDO vacc
417	1	Kamero	Oct 20	R	
423	1	Bellwood	Oct 20	C	
433	1	Rudolph	Nov 8	L	
394	2	Storm	Oct 21	C	
359	3	Sam	Nov 17	L	
400	2	Powerful	Nov 28	R	
430	1	Brock	Nov 22	R	
431	1	Beechwood	Nov 22	L	
425	1	Jay	Dec 9	C	
106	10	Engraver	Dec 7	L	
390	2	Salem	Dec 15	R	
398	2	Storm	Jan 13	C	

437	1	Top Gun	Dec 9	C
444	1	Outside	Dec 9	L
441	1	Billionaire	Jan 3	R
438	1	Rudolph	Jan 6	L
426	1	Daniel	Jan 18	R
434	1	Brock	Jan 18	C
445	1	Storm	Jan 18	L
428	1	Demand	Jan 21	C
440	1	James	Jan 22	R
435	1	Demand	Jan 25	R
453	1	Jay	Jan 26	L
451	1	Jay	Jan 30	C
370	3	Sam	Jan 28	L
319	4	Simon	Feb 3	C
399	2	Rudolph	Feb 6	R
429	1	Kamero	Feb 5	C
439	1	Bellwood	Feb 6	R
455	1	Demand	Feb 9	L
353	3	Sam	Feb 11	C
304	5	Supersire	March 2	L
408	2	Brock	March 3	R
446	1	Bellwood	March 2	R
456	1	Billionaire	March 3	C
443	1	Outside	March 6	L
407	2	Jay	March 16	R
362	3	Samuel	March 21	C
381	3	Rudolph	March 23	L
405	2	Luke	March 25	L
334	4	Grand	March 26	R
396	2	Rudolph	March 26	C
410	2	Jay	March 26	L
224	7	Sailor	March 26	C
397	2	Zebo	April 12	R

Spare heifer #454 due March 15
Spare cow #376 due April 16

7. **Possible 8 groups of cows and 8 groups of heifers. The first group of cows will likely be excluded as due dates are too close and Lin Pro is not on site as of Oct. 5. First set of heifers will start if Lin Pro available to feed by Oct 10. There will be some difficulty in keeping cows in boxstalls for 10 days post calving in December and March when there are 12 and 14 due dates. Cows may be housed in tiestalls after calving if stalls are available or may be moved to the high production group and fed concentrate, Lin Pro or soybeans in the milking parlour if products prove palatable enough.**
There are age differences of up to 6 months within groups of heifers which may have some effect on results as older heifers in better condition tend to have more problems at calving.

8. **Blood Samples:**

   Collect 20 mls (jugular) on a). day cow is moved to boxstall – no later than day after move.
   b). day of calving
   c). 5 days post calving
   d). 10 days post calving

   Blood samples will be analysed under direction of A. Van Kessel
   Samples may be routinely collected by M. Fehr or E. Lammerding – require a back up number for some weekend days. Blood samples collected on weekends will be refrigerated in dairy barn until Monday am ????
   Assuming 15 groups (45 cows and heifers) there will be 45 x 4 = 180 sets of blood samples.

9. **Milk Samples:**

   Colostrum samples will be collected from the first and second milking and a milk sample will be collected on day 10 for CLA analyses by H. Soita. Samples will be frozen and stored in the freezer in Room 117 of the Animal Science building. Assuming 45 cows x 3 = 135 samples for CLA analyses.

   Colostrum samples and day 5 and 10 milk samples will be sent to Regina for fat, protein, lactose and somatic cell counts. Samples will be collected on schedule and refrigerated. Samples will be sent to Regina on a once a week basis – send on Wednesdays.

   Colostrum from cows is routinely frozen for sale to the Saskatoon Colostrum Company (heifer colostrum was also saved for SCC during July and August of 2001). Check with SCC for availability of immunoglobin data – also check if SCC still wants first milking from heifers.

10. **Bodyweights: Cows will be weighed on day of moving to boxstalls, day of calving and on day 10 post calving.**

11. **Feed Intake: Individual feed intake records are maintained from the day the cow moves into a boxstall until the cow moves to the high production group. TMR samples will be collected once a week for dry matter analyses. Samples will be composited every 4 weeks for lab analyses.**

12. **Health Record: All treatments will be recorded.**

13. **Lin Pro and Soybean requirement @ 1 kg per day for 25 days x 15 animals = 375 kg**